Appendix C
Relationship Between Surface and Subsurface Contaminant of Concern Concentrations

1 Introduction

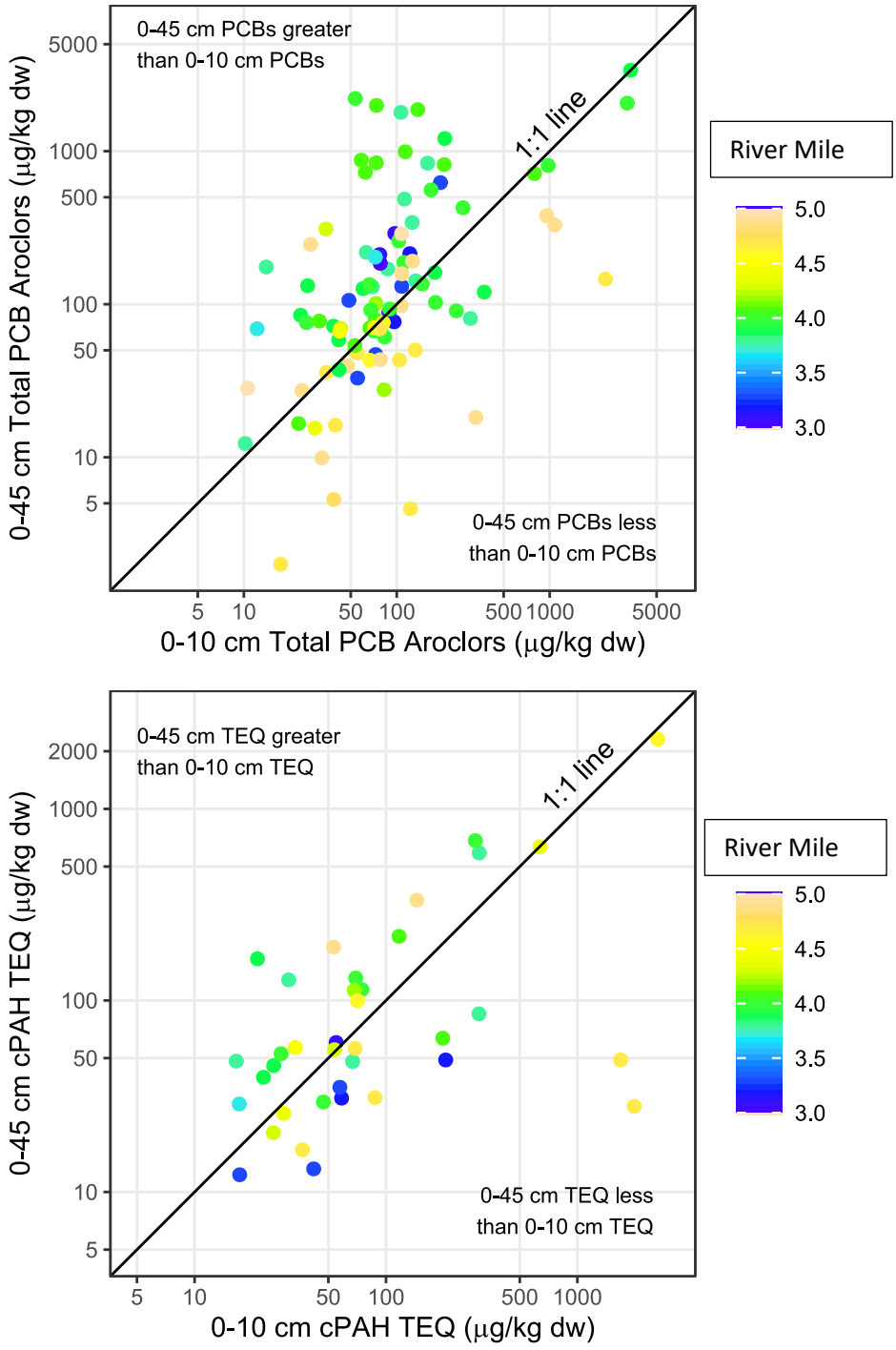
This appendix was prepared to address a US Environmental Protection Agency (EPA) request to compare surface and subsurface sediment contaminant of concern (COC) concentrations in upper reach locations (river mile [RM] 3.0 to RM 5.0]) in the Lower Duwamish Waterway (LDW) Pre-Design Investigation (PDI). The PDI data were used to compare COC concentrations in surface sediment (0–10 cm) and subsurface sediment (0–45 cm or 0–60 cm) at all locations where both surface and subsurface sediment samples were collected. Samples were co-located if they were collected at the same location and the surface grab and core were collected within 10 ft of one another. Comparisons were made using four human health risk drivers: total polychlorinated biphenyl (PCB) Aroclors, carcinogenic polycyclic aromatic hydrocarbon (cPAH) toxic equivalents (TEQs), dioxin/furan TEQs, and arsenic.

2 Comparison of Surface Sediment (0–10 cm) to Subsurface Intertidal Sediment (0–45 cm)

The PCB concentrations and cPAH TEQs for surface sediment and subsurface intertidal sediment are compared in Figure C-1. The two datasets (0–10 cm and 0–45 cm) are significantly correlated for both PCBs (non-parametric Spearman's rank correlation rho=0.53, $p << 0.001$, n=97) and cPAHs (rho = 0.51, p = 0.001, n=38). The deviations from the 1:1 line were calculated, with positive values indicating that 0–45-cm concentrations were greater than 0–10-cm concentrations. Using a sign test, these deviations were tested for whether the median value was significantly different from zero, where a median value of zero indicated that exactly half the samples were above and half were below the line. Histograms for the distribution of these deviations from the 1:1 line for PCB concentrations and cPAH TEQs are shown in Figure C-2. The sign tests did not reject the null hypothesis ($p < \alpha = 0.05$) that the median values were different from zero (PCBs sign test p = 0.13, cPAH sign test p = 1.0). These results indicate that there was no consistent bias for the surface concentrations to be greater or less than the subsurface concentrations.

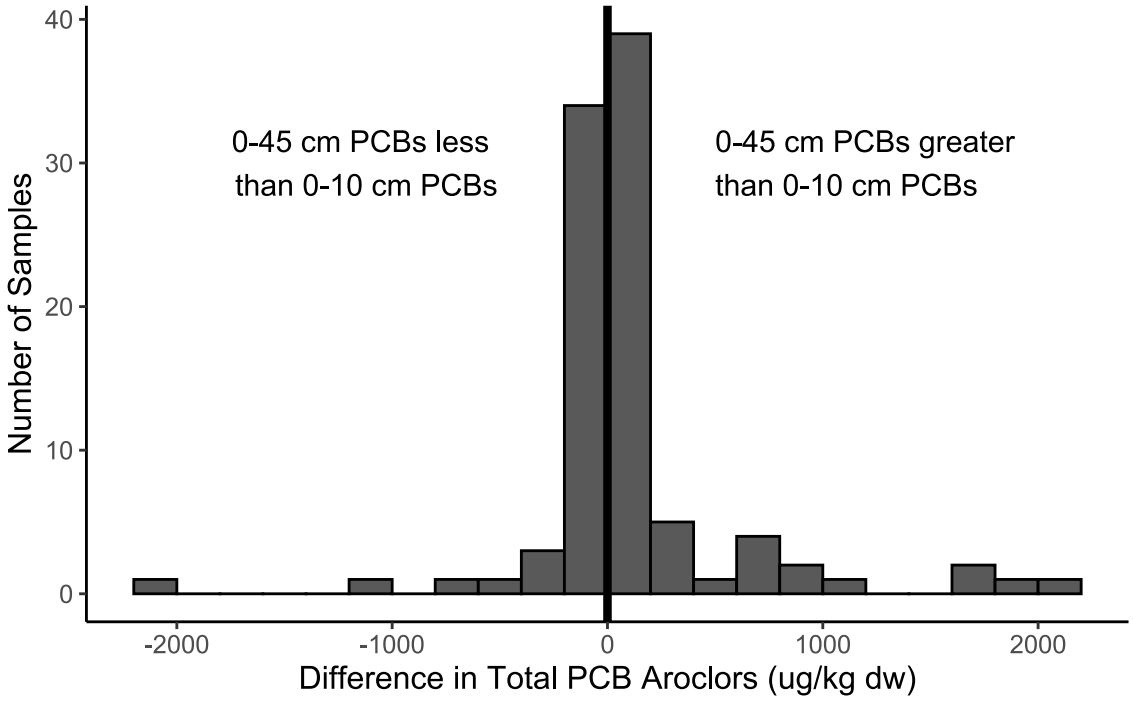
Samples within the same river mile were distributed above and below the 1:1 line, indicating no clear spatial trend. Similar results are shown for dioxin/furan TEQ values and arsenic concentrations (Figure C-3), and Spearman's rank correlations were significant within both datasets (dioxin/furan TEQ rho = 0.60, $p < 0.001$, n=37; arsenic rho = 0.45, $p < 0.001$, n=67). The distributions of deviations from the 1:1 line are shown in Figure C-4; the sign test was not rejected for dioxin/furan TEQ values (p = 0.74), indicating there was no tendency for concentrations in the 0–45-cm samples to be greater or less than those in the 0–10-cm interval. The results for arsenic were statistically significant (p = 0.036), indicating arsenic concentrations for 0–45 cm tended to be slightly lower than for the 0–10-cm interval, with a median difference of -1.16 mg/kg dry weight (dw).

Figure C-1
Scatterplots of Total PCBs and cPAH TEQ Values in Surface (0–10 cm) Versus Subsurface Sediment (0–45 cm) in the Intertidal



Points color coded by river mile. Black line is the 1:1 line; points above this line have subsurface concentrations greater than those in the surface.

Figure C-2
Histogram of Differences in Total PCB Aroclors and cPAH TEQ Values in Surface (0–10 cm) Versus Subsurface Sediment (0–45 cm) in the Intertidal



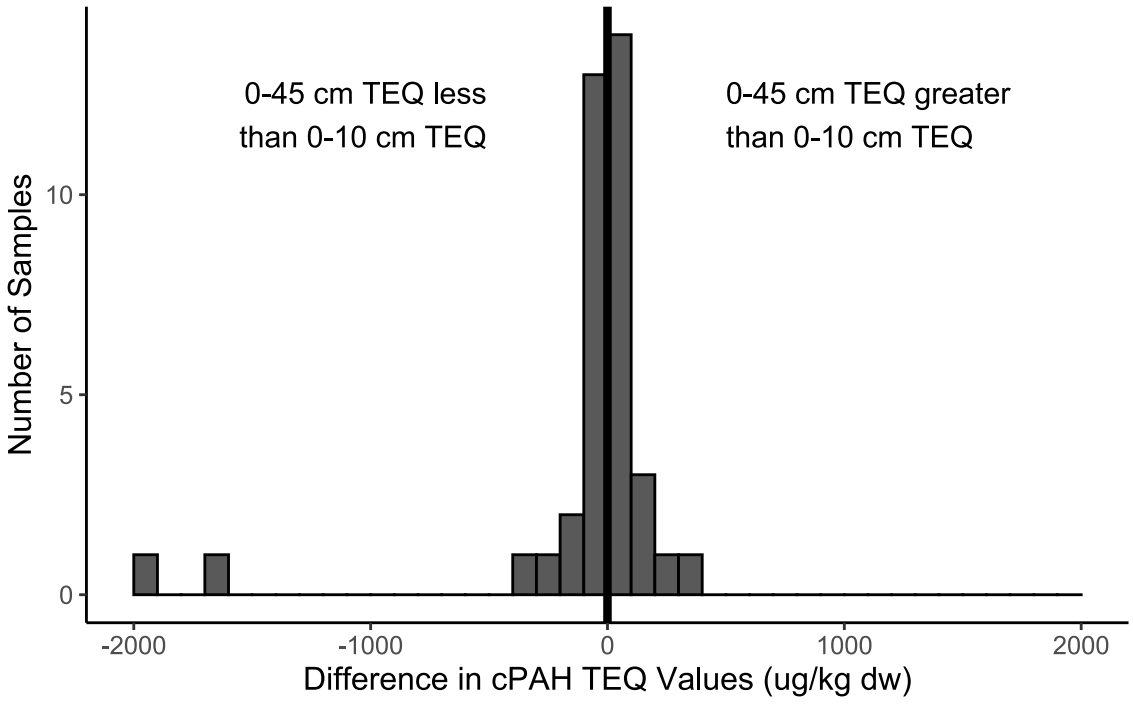
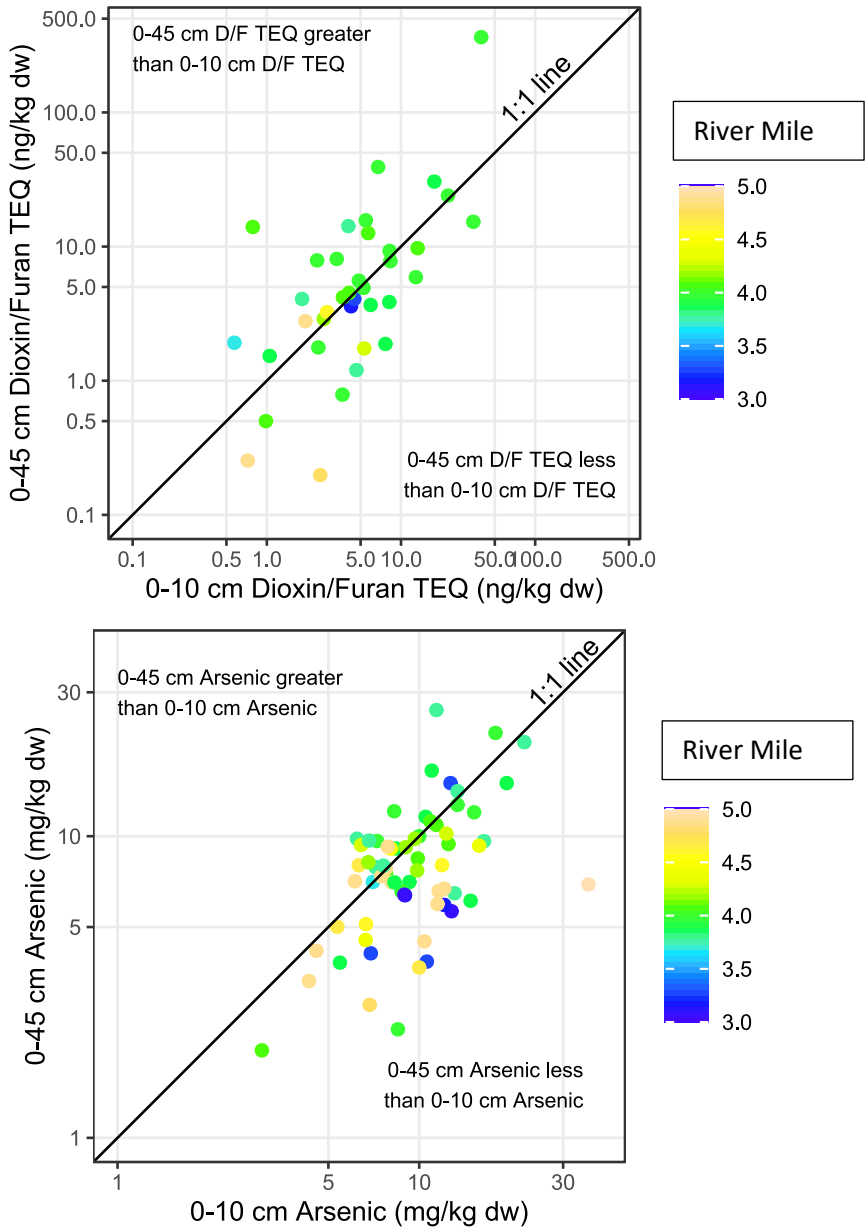
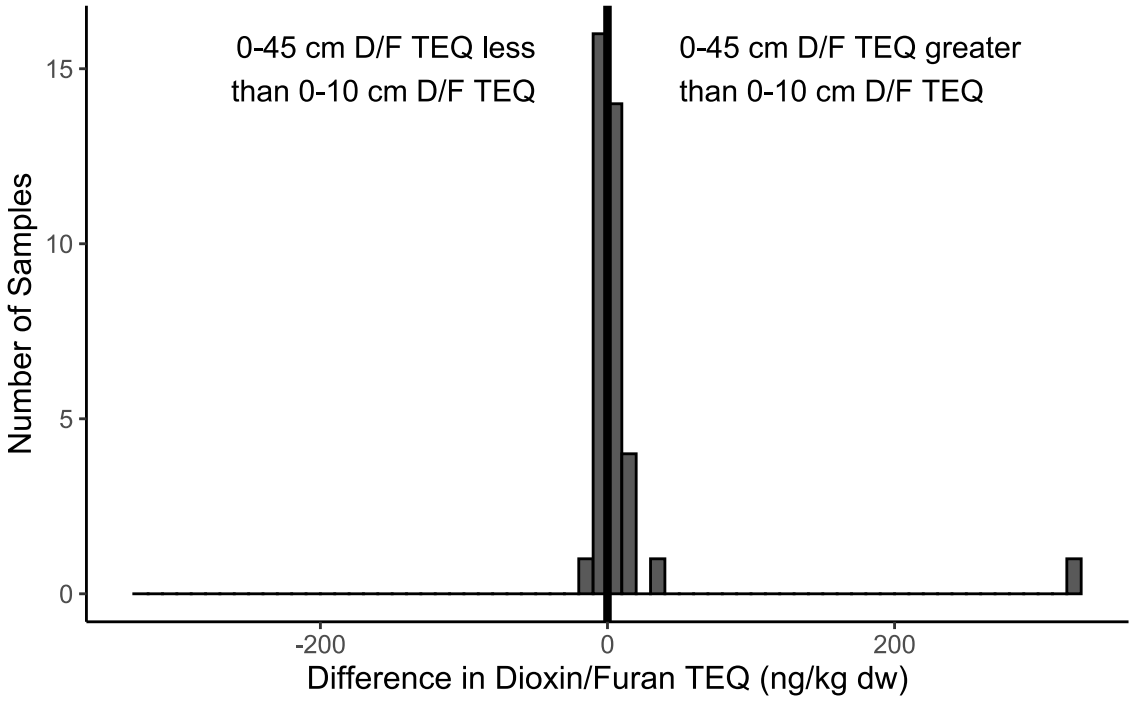


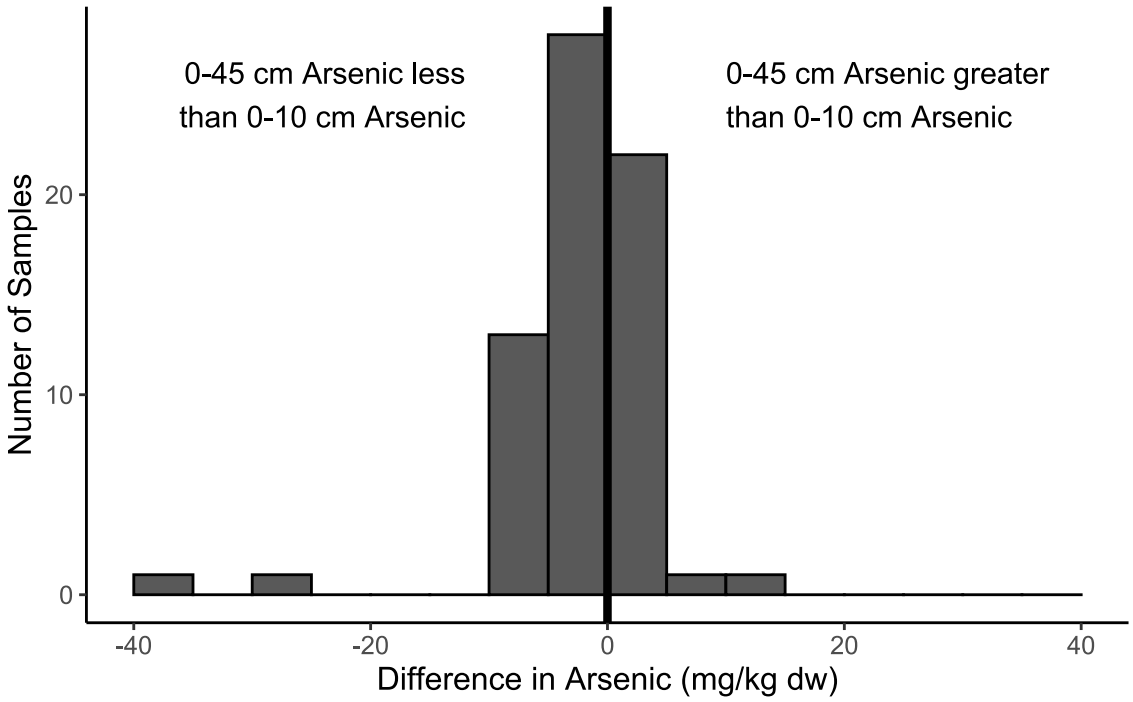
Figure C-3
Scatterplot of Dioxin/Furan TEQ Values and Arsenic Concentrations in Surface (0–10 cm) Versus Subsurface Sediment (0–45 cm) in the Intertidal



Points color coded by river mile. Black line is the 1:1 line; points above this line have subsurface concentrations greater than those in the surface.

Figure C-4
Histogram of Differences in Dioxin/Furan TEQ Values and Arsenic in Surface (0–10 cm) Versus Subsurface Sediment (0–45 cm) in the Intertidal





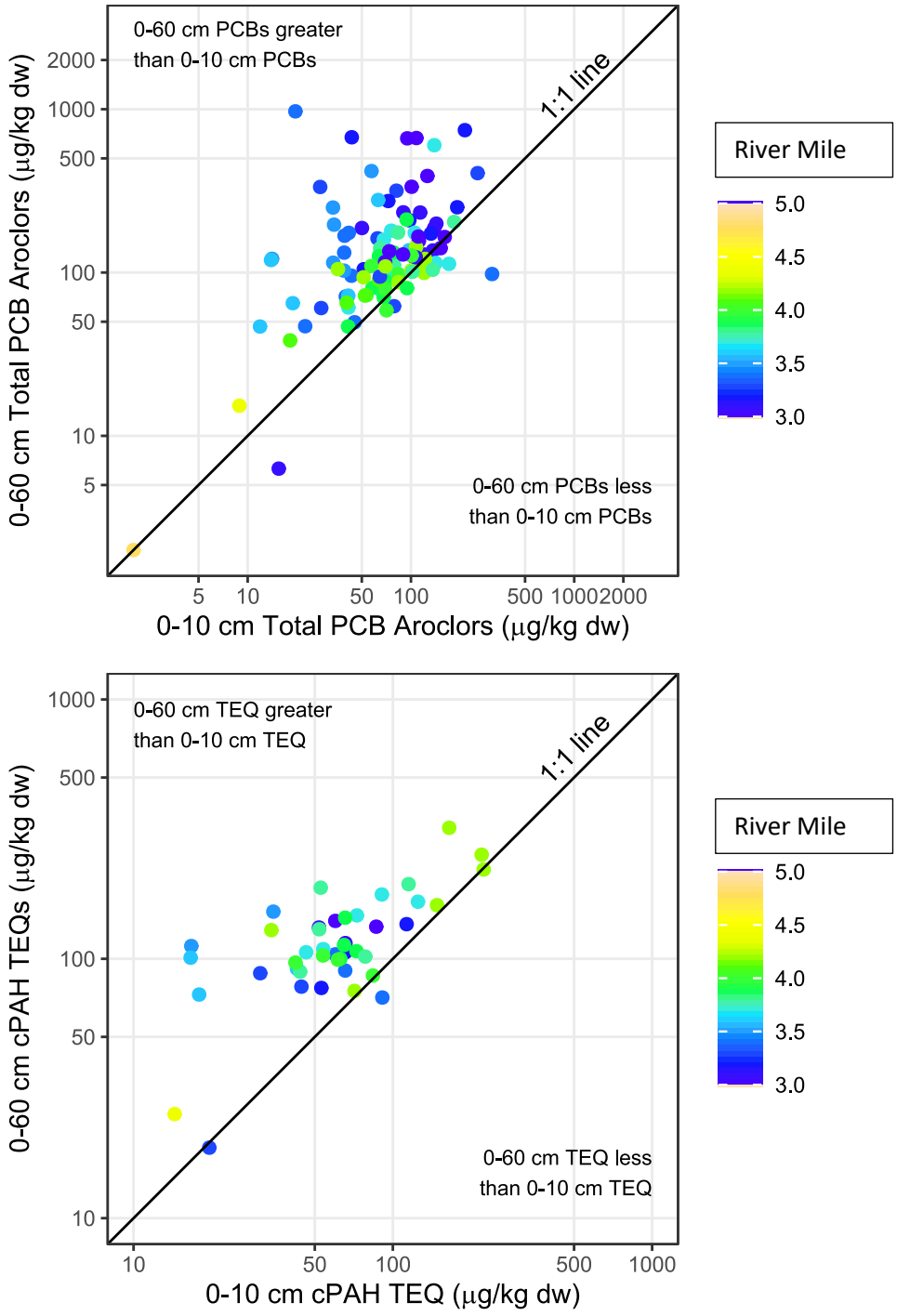
3 Comparison of Surface Sediment (0–10 cm) to Subsurface Sediment (0–60 cm) in the Subtidal

PCB concentrations and cPAH TEQs in subtidal subsurface sediment (0–60 cm) were similar to or greater than concentrations in surface sediment (0–10 cm) (Figure C-5). These Spearman's rank correlations were statistically significant for both PCBs (rho = 0.41, $p << 0.001$, n = 104) and cPAH TEQ (rho = 0.51, $p < 0.001$, n = 45). The majority of the sampling locations plot above the 1:1 line (Figure C-6), indicating that the 0–60-cm subsurface sediment PCB concentrations and cPAH TEQs tend to be greater than the surface sediment results (i.e., both sign tests were statistically significant, $p << 0.001$, with median deviations greater than zero).

The data were insufficient to adequately assess the relationship for dioxin/furan TEQs (n = 8, Figure C-4), whereas arsenic had no consistent tendency for surface sediment concentrations to be greater or less than subsurface (0–60 cm) sediment concentrations in the subtidal samples (Figures C-4 and C-5). This correlation was statistically significant (with Spearman's rank correlation rho = 0.42, p = 0.002, n=49), and the sign test failed to reject the null hypothesis of a median difference of zero (p = 0.67, n=49).

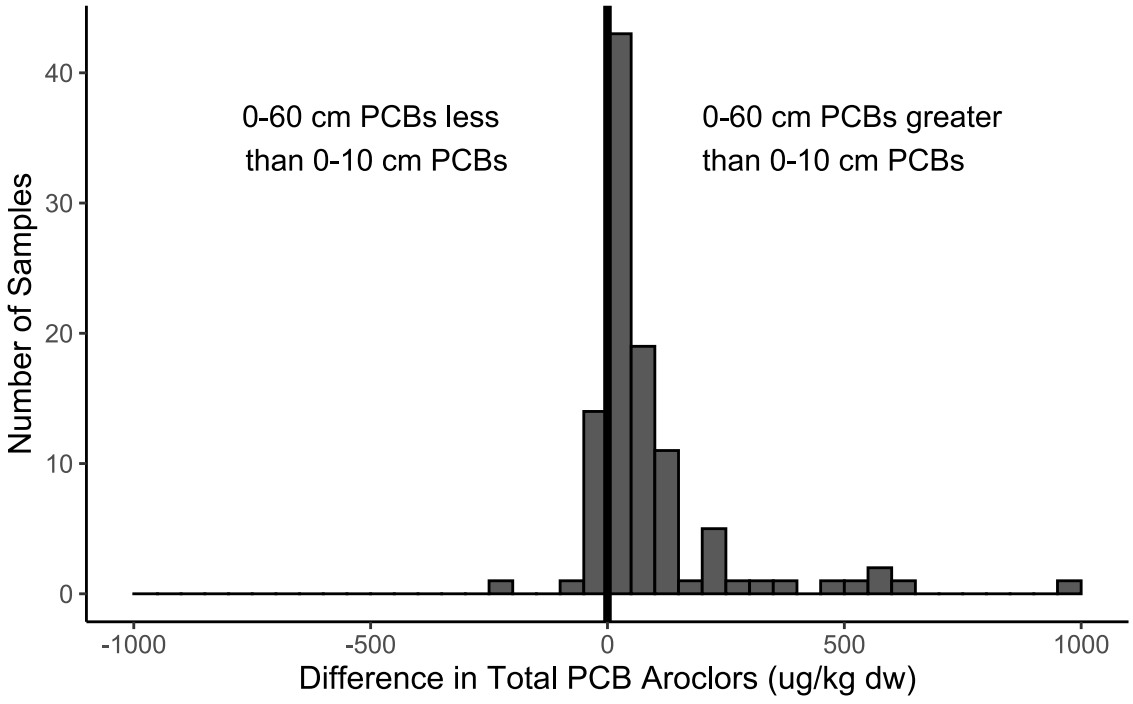
Data assessed in this appendix are summarized in Attachment C1.

Figure C-5
Scatterplots of Total PCB Aroclor Concentrations and cPAH TEQ Values in Surface (0–10 cm) Versus Subsurface Sediment (0–60 cm) in the Subtidal



Points color coded by river mile. Black line is the 1:1 line; points above this line have subsurface concentrations greater than those in the surface.

Figure C-6
Histogram of Differences in Total PCB Aroclors and cPAH TEQ Values in Surface (0–10 cm) Versus Subsurface Sediment (0–60 cm) in the Subtidal



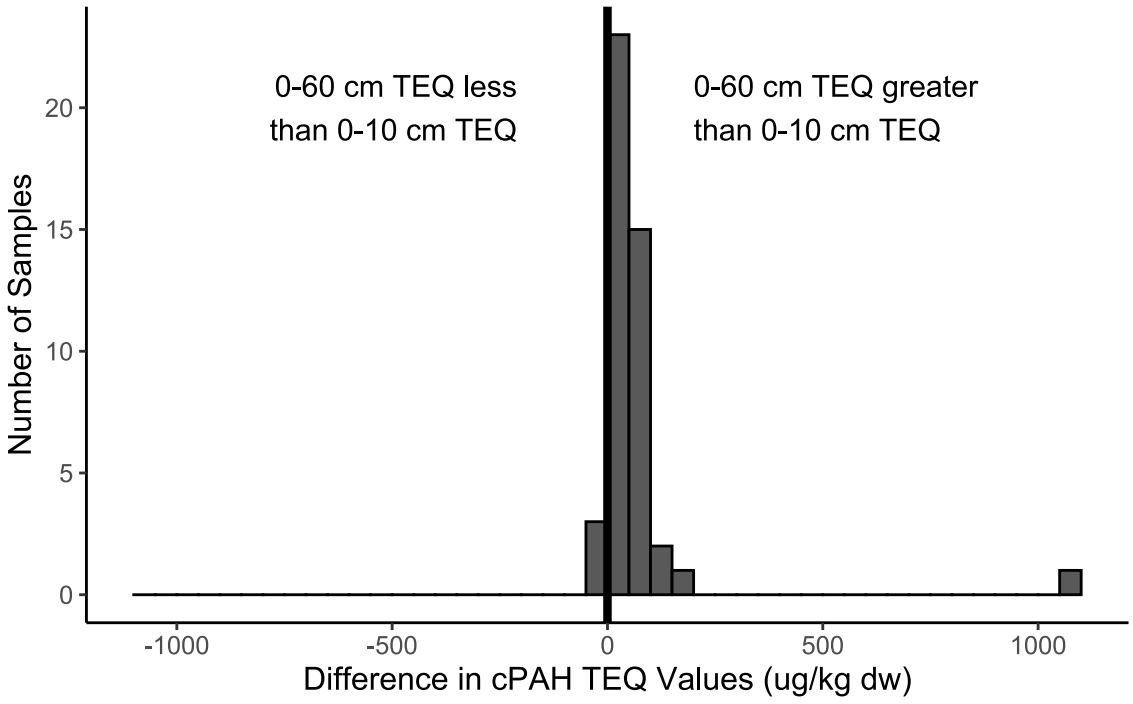
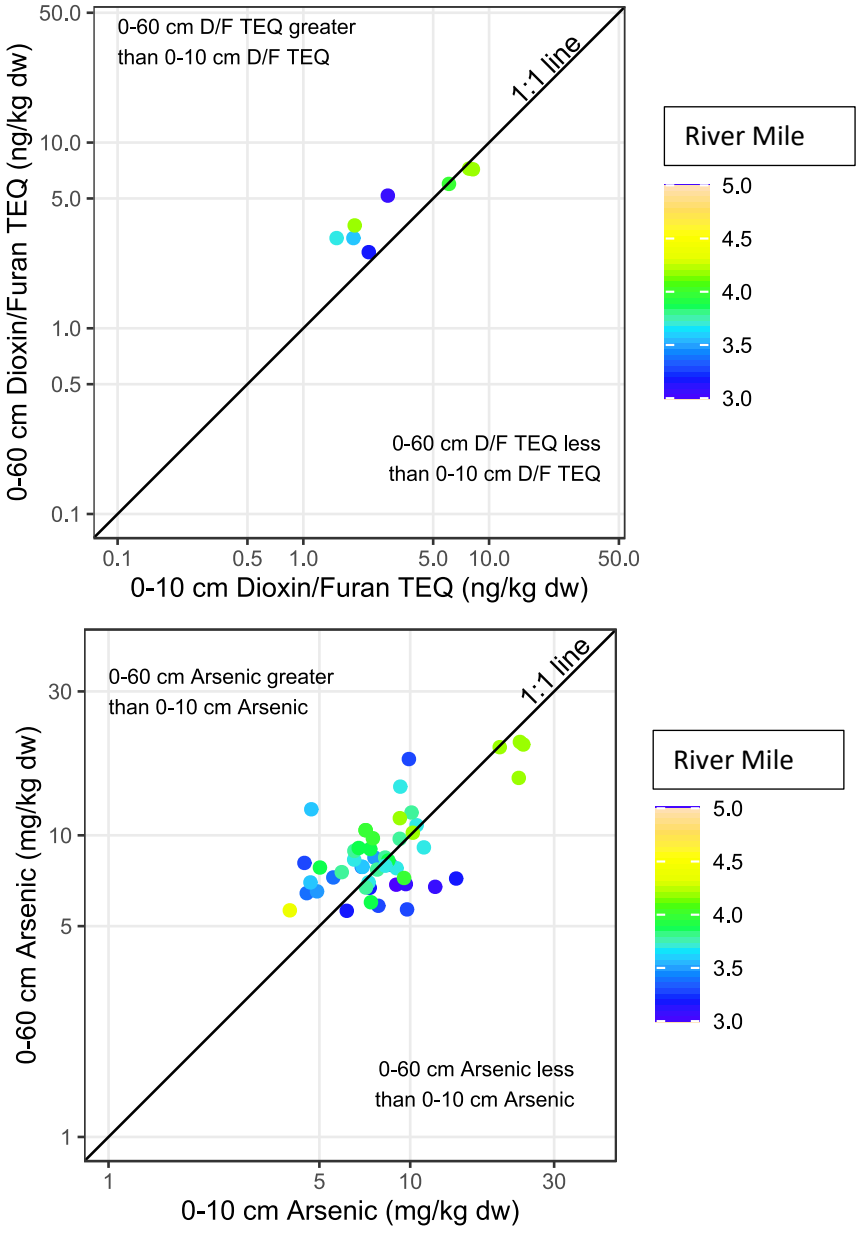
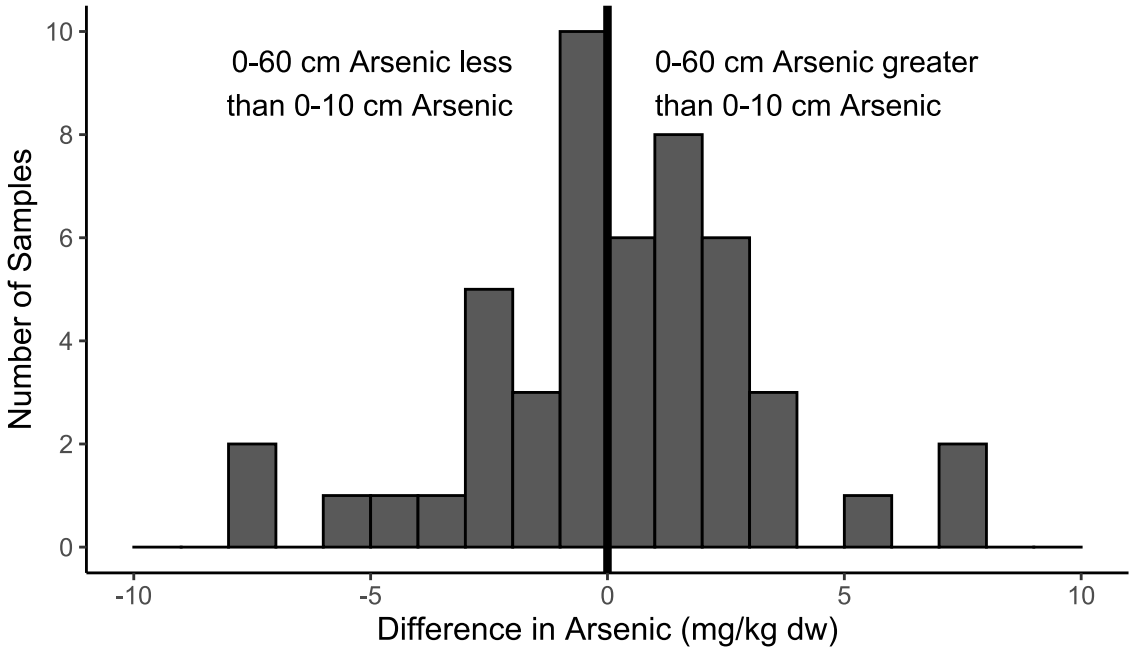


Figure C-7
Scatterplot of Dioxin/Furan TEQ Values and Arsenic Concentrations in Surface (0–10 cm) Versus Subsurface Sediment (0–60 cm) in the Subtidal



Points color coded by river mile. Black line is the 1:1 line; points above this line have subsurface concentrations greater than those in the surface.

Figure C-8
Histogram of Differences in Arsenic Concentrations in Surface (0–10 cm) Versus Subsurface Sediment (0–60 cm) in the Subtidal



4 References

EPA. 2021. Proposed explanation of significant differences. Draft for public comment. Lower Duwamish Waterway Superfund site. US Environmental Protection Agency Region 10, Seattle, WA.

5 Attachments

Attachment C1 Data Assessed